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PATENT SPECIFICATION

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(54) METHOD AND APPARATUS FOR DETERMINING PLAY BETWEEN COMPONENTS

(71) We, DAIMLER-BENZ AKTIEN-GESELLSCHAFT, of Stuttgart-Untertürkheim, Germany, a Company organised under the Laws of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to a method and apparatus for determining valve play or clearance in internal combustion engines, especially vehicle engines.

15 In internal combustion engines, it is necessary to ensure precise maintenance of the valve clearance. Initially, it must be accurately set on assembly and thereafter it must be checked from time to time and, if necessary, reset. This is generally difficult, because
 20 valve play occurs in places to which access is difficult, so that accuracy is not easy to achieve. The present invention seeks to provide a method and apparatus by which valve play can be determined accurately for its setting during assembly and also for subsequent checking.

25 According to the invention, in a method of determining the valve play, a valve-actuating rocker is moved cyclically to and fro, within the range permitted by the play, between the two limit positions of the rocker by the action of an external force, the movement is sensed, the limit values in the cycle are determined and the difference determined from them is indicated. By an external force
 30 is meant a force other than a force applied for the normal operation of the valve gear.

35 The invention utilises the principle of simulating the movement of an accessible part of the valve gear in relation to a stationary other part and determining the play, by reference to the limit positions of the moving part, not at the place where the play actually occurs, but at a substitute, accessible,
 40 place.

45 The invention has the advantage that it is immediately possible, on assembly or on sub-

sequent checking, to set the valve clearance of an engine easily and with precision. The required apparatus may, for example, be suspended, like other assembly tools, above a work station on an assembly line. For use, the apparatus is then placed on the cylinder head and clamped in position.

50 Preferably electromagnetic force is employed to move the rocker, although this is not essential. Preferably also the limit values are determined by an inductive sensor or transducer. Two measurements per cycle may be effected, one in each limit position, at the sensor or transducer. It is further proposed that the difference between the measured values, the play, should be compared with a prescribed upper and lower limit value, an "acceptable" signal being
 60 given between these two limit values, whereas a first "fault" signal is given above the upper value and a second "fault" signal below the lower value.

70 With the above-proposed method, the non-identity of the test position with the position where the play actually occurs can readily be taken into account automatically, especially if the sensing and other associated components are electrical. Preferably the two "fault" signals are given as different coloured light signals, so that the operator can immediately detect whether the play is too large or too small.

80 For carrying out the aforesaid method for determining valve play in an internal combustion engine, use may be made of apparatus in which an electromagnet and a sensor for each rocker are disposed in a housing adapted to be placed on the cylinder head and the electromagnet is connected to a cyclical signal-transmitter and the sensor to an indicating means. Advantageously, the latter connection is by way of an amplifier. A memory device for the values measured in the limit positions
 85 may be associated with the sensor, the said sensor or amplifier being controllable from the transmitter.

In one embodiment of the invention, a

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comparator or threshold-value switch is so associated with the sensor or amplifier as to compare the actual values measured with prescribed desired values and the indicating means comprises three elements which respond to signals of the said comparator or switch when the actual values are above, below and between the desired values respectively. In this case, it is possible to arrange all the electrical components, including the indicating means, in the housing itself. Alternatively, the electrical components, such as the amplifier and transmitter, are disposed in a separate control unit, so that only the electro-magnet, the sensor and, possibly, indicating lamps are arranged in the housing, which is to be placed on the engine.

A separate set of indicating elements may be associated with each sensor and arranged in the housing above the relevant rocker. Preferably, however, only one, common, set of indicating elements is provided in the housing and can be switched selectively into circuit with the several sensors.

By way of example, one manner of carrying the invention into effect will now be more fully described with reference to the accompanying drawings, in which:—

Fig. 1 is a diagrammatic representation of a form of apparatus employed, and Fig. 2 is an explanatory diagram.

The apparatus for determining valve play, in an internal combustion engine, illustrated in Fig. 1 is accommodated in a housing 10. The upper part of the housing 10 is box-shaped and its lower part comprises a frame 11 with side apertures 12, through which the valve-actuating mechanism 13 of the engine remains accessible when the housing 10 is placed bodily on the head of the cylinder block 14 of the engine. The top of the housing 10 has an eye 15 by which the housing can be suspended above an assembly line, like other assembly tools. An electrical cable connected to the apparatus is not shown for the sake of simplicity.

An electro-magnet 16 for each rocker 17 of the mechanism 13 is disposed in the housing 10. Immediately beside each magnet 16 is an inductive test sensor 18 which rests by a point on the respective rocker 17. The energisation of the magnet 16 is controlled by a cyclical signal-transmitter, indicated diagrammatically at 19, in the housing 10. The sensor 18 is connected through a measured-value transducer 20 and amplifier 21 to a memory device 22, which is itself connected through a comparator 23 or threshold-value switch to an indicating instrument 24. The latter comprises three indicator lamps 25, 26 and 27 disposed in the front wall of the housing 10.

The manner of operation of the apparatus will now be described with reference to Fig. 2. The electro-magnet 16 is excited cyclically

by current pulses from the transmitter 19 (line I) so that the rocker 17 is moved to and fro between its two limit positions in the same cycle. It is abutted at this time against the virtually stationary valve stem 28 and its two limit positions are determined by contact with the cam 29 on the one hand and with a ball-head bearing 30 on the other hand. The magnet 16 must be at such a distance from the rocker 17 that the latter cannot strike the former. The movement of the rocker 17 is illustrated in line II of Fig. 2.

The position of the sensor 18 is ascertained by the transducer 20. In order that this shall occur precisely in each of the limit positions of the rocker 17, the amplifier 21 is controlled from or simultaneously with the transmitter 19 so that (lines III and IV in Fig. 2) the two limit values are ascertained. This means that the amplifier 21 opens for a short time in both the one and the other limit position, so that the measured value ascertained can be passed to the device 22 and stored there. The values ascertained are compared with each other in the comparator 23 and the difference ascertained. The difference is then compared with prescribed desired values and the result passed to the indicating instrument 24. If the difference ascertained is between the two prescribed values, then the valve play has the "acceptable" value and the corresponding indicator lamp 25 lights up green, for instance. If the play is too large, then the next lamp 26 lights up yellow, for instance. The play can then be corrected appropriately, by means of a hexagon 31 on the ball head 30, until the yellow lamp 26 is extinguished and the green lamp 25 lights up. A similar situation arises if the play is too small. In this case, the third lamp 27 lights up red, for example, and the hexagon 31 is turned until the green lamp 25 lights up again. The operator need be guided only by the lamps and can adjust the play accurately to be within its tolerances. The test operation is repeated for each valve, the several magnets 16 and sensors 18 being switched into and out of circuit electrically for each operation. The lamps 25 to 27 then indicate for the respective rockers 17 sensed in each operation. To simplify control, all of the magnets 16 may be controlled from one signal-transmitter and excited simultaneously. In this case however, only the one sensor for a respective rocker is switched into circuit at a time.

WHAT WE CLAIM IS:—

1. A method of determining the play in valve gear of an internal combustion engine, wherein a valve-actuating rocker is moved cyclically to and fro, within the range permitted by the play, between the two limit positions of the rocker by the action of an external force, the movement is sensed, the limit values in the cycle are determined and

the difference determined from them is indicated.

2. A method according to claim 1, wherein the said movement of the rocker is produced by electromagnetic force and the limit values are ascertained by an inductive sensor.

3. A method according to claim 1 or 2, wherein two measurements, one in each limit position, are made per cycle at the sensor element or a measured-value transducer.

4. A method according to any one of claims 1 to 3, wherein the difference between the measured values is compared with prescribed upper and lower limit values and an "acceptable" signal is given between the said two limit values, a first "fault" signal above the upper limit value and a second "fault" signal below the lower limit value.

5. A method of determining play in valve gear of an internal combustion engine substantially as hereinbefore described with reference to the accompanying drawings.

6. Apparatus for carrying out the method according to any one of claims 1 to 5 wherein an electromagnet and a sensor for each rocker are disposed in a housing adapted to be placed on the cylinder head and the electromagnet is connected to a cyclical signal-transmitter and the sensor to an indicating means.

7. Apparatus according to claim 6, wherein a memory device, for the values measured in the limit positions, is associated with the

sensor and the sensor or a measured-value amplifier connected to the sensor is controllable by the transmitter.

8. Apparatus according to claim 6 or 7, wherein a comparator or threshold-value switch is so associated with the sensor or amplifier as to compare the actual values measured with prescribed desired values and the indicating means comprises three elements which respond to signals of the said comparator or switch when the actual values are above, below and between the desired values respectively.

9. Apparatus according to any one of claims 6 to 8, wherein a set of indicating means is associated with each sensor and is arranged in the housing above the respective rocker.

10. Apparatus according to any one of claims 6 to 9, wherein a single set of indicating means arranged in the housing is selectively switchable into circuit with the several sensors.

11. Apparatus for determining play in valve gear of an internal combustion engine substantially as hereinbefore described with reference to the accompanying drawings.

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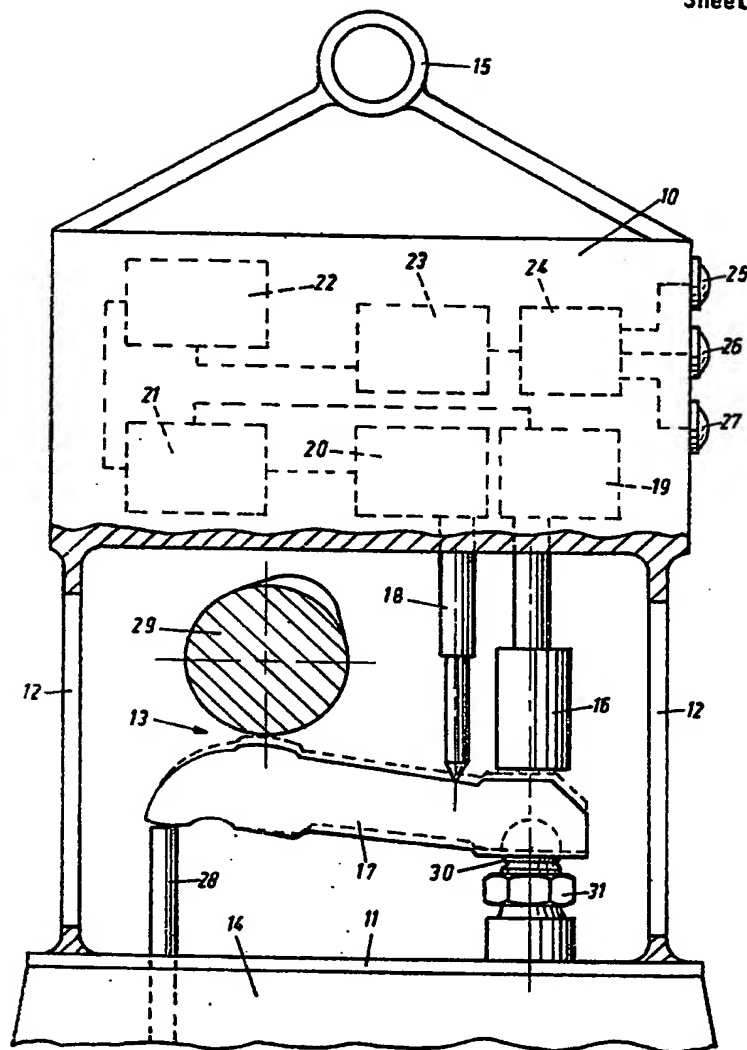


Fig.2

